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Implementation Of Differential Phase Contrast On A Scanning Transmission X-ray Microscope

M. Feser, C. Jacobsen, and J. Kirz (SUNY, Stony Brook)

Beamline(s): X1A

Introduction: The motivation for phase contrast imaging in soft x-ray microscopy is the potentially significant reduction in radiation dose necessary to image a specimen compared to absorption contrast [1]. The implementation of phase contrast in scanning transmission x-ray microscopy (STXM) is not simple, because the number of optical elements has to be kept small due to their low efficiency. Since phase gradients in the specimen will cause the x-rays to be refracted in a similar way to a prism, the easiest way to generate differential phase contrast (DPC) is to implement a segmented detector and measure overall beam deflection [3]. Another approach is to use a beam splitter in front of the focusing optic to produce two beams only slightly displaced, which interfere in the detector plane and use a segmented detector to measure the shift of the interference fringes (Nomarski Differential Interference Contrast = NDIC) [2].

Methods and Materials: The room temperature scanning transmission x-ray microscope at beamline X1A at the NSLS has been equipped with a novel segmented silicon detector [see separate abstract] for obtaining DPC and NDIC contrast images near the oxygen K-edge (540eV). For NDIC a beamsplitting grating [2] has been installed into the beamline.

Results: Images of dried silica spheres and the corner of a silicon nitride window have been acquired in DPC and NDIC contrast demonstrating differential phase contrast in STXM.

Conclusions: Further efforts are being directed to using DPC for samples with weak absorption, but significant phase contrast. The method is very promising for work on biological frozen hydrated samples as well as STXM at higher photon energies, since absorption decreases much more rapidly than phase effects with higher energy.

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References:

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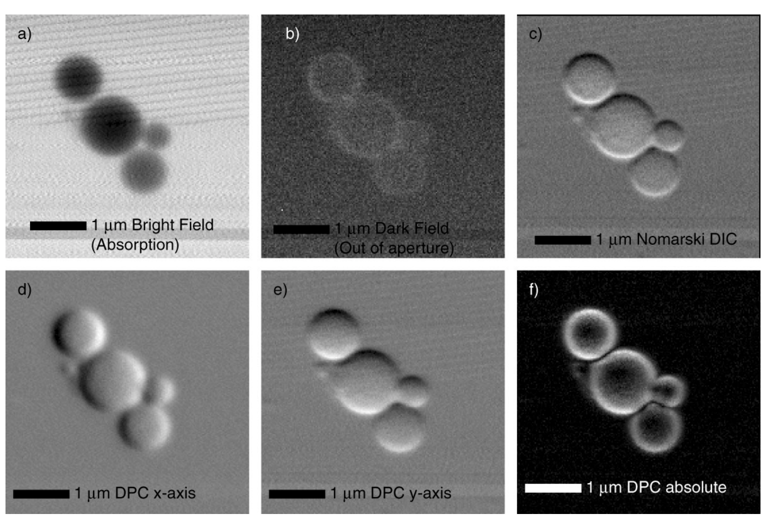

Figure 1: Silica sphere in absorption, dark field, NDIC and DPC contrast